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Research Article

The Role of Value on Mathematics Between Self-Efficacy and Like Mathematics: A Moderated Mediation Analysis

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Abstract: This study examines the moderating effects of parents' belief in the importance of mathematics on the relationship between students' mathematics self-efficacy and their enjoyment of mathematics among 8th-grade students in the TIMSS 2019 data. Mediation analysis revealed that higher self-efficacy in mathematics increased students' enjoyment of the subject, with students' value of mathematics partially mediating this relationship. The parents' attitudes significantly moderated the mediating effect, emphasizing their critical role in shaping students' attitudes toward mathematics. Notably, the indirect effect of students' value of mathematics was more substantial when parents did not perceive mathematics as important. These findings highlight the complex interplay among students' self-beliefs, their value of mathematics, and parents' value of mathematics, collectively influencing students' enjoyment of mathematics. Further research could explore the implications of these relationships for educational practices.

Keywords: Mathematics Self-Efficacy, Parents' Value of Mathematics, Students Like Learning Mathematics, Students' Value of Mathematics

1. Introduction

Mathematics plays a crucial role in personal growth and development across various scientific fields and everyday life (Sharma, 2021). Considering this, it is not unexpected for mathematical achievement to be highly valued. Various research studies are conducted to increase mathematical achievement. Researchers believe that it is crucial to identify significant factors that influence exam performance, particularly those that can be changed through intervention and may result in enhanced academic achievement (Stankov et al., 2012). For example, mathematics educators have observed the connection between cognition and emotion and the impact of emotions on promoting creativity in mathematics (Di Martino & Zan, 2011). The relationship between cognition and emotion in mathematics education research is referred to as affect. Studies in this area have increased in recent years (Chen, 2022; Di Martino, 2019; Dowker et al., 2019; Hwang et al., 2017). Since it serves as a link between beliefs and emotions, attitudes toward mathematics is particularly interesting within the affected domain (Di Martino & Zan, 2011).

Di Martino and Zan (2010) developed a multidimensional model to define attitude based on practicality. This model consists of three components: emotional disposition (liking or disliking mathematics), vision of mathematics (instrumental or relational), and perceived competence (success or failure in mathematics). The study revealed that the interactions between the three components of attitude impact mathematical understanding and shape pupils' mathematics encounters in various ways. This approach emphasized the crucial role of attitude in connecting beliefs and emotions, enabling the exploration of how students' feelings towards mathematics, their self-beliefs, and their beliefs about the subject interact with each other (Di Martino & Zan, 2011). Hwang et al. (2017) stated that it would offer a suitable foundation for understanding the connection between attitudes toward mathematics and performance in mathematics.

Researchers claim that the interactions between cognition and emotion are most likely to occur when dealing with unfamiliar or difficult tasks. Based on this, some researchers have suggested that the Trends in International Mathematics and Science Study (TIMSS) shows how students can solve non-

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routine and multi-step problems as they can solve a routine problem in unfamiliar ways (Mullis et al., 2012; Hwang et al., 2017). The TIMSS provides an extensive dataset for investigating the connection between students' attitudes and reasoning abilities (Ferrini-Mundy & Schmidt, 2005). Therefore, in this study, we used the TIMSS 2019 international database, which is the latest available dataset. Particularly, we focused on four components of attitude toward mathematics. These are Students' Mathematics Self-Efficacy (MSE), Students Like Learning Mathematics (SLM), Students Value Mathematics (SVM), and Parents' Valuing of Mathematics (PVoM). We believe that there is a relationship between the theoretical framework proposed by Di Martino and Zan (2010) and the analytical methodology employed to assess attitude in TIMSS 2019.

1.1. Mathematics Self-Efficacy (MSE)

Students' self-efficacy beliefs relate to their assessments of confidence in their ability to complete academic tasks or achieve success in certain academic activities (Pajares & Graham, 1999). Students' self-efficacy has been examined as a personal attribute that directly impacts their actions in settings linked to mathematics (Bandura, 1997). According to Schunk and DiBenedetto (2021), students who have confidence in their mathematical skills are more likely to persist and put in effort to learn, which ultimately impacts their academic achievement. Research has shown that students with a high level of mathematics self-efficacy tend to perform better, set more ambitious objectives, and have greater resilience in the face of difficulties (Bandura, 1997). Researchers in mathematics have prioritized the importance of individuals' self-efficacy in mathematics as it is a strong indicator of their academic achievement (Lee, 2009; Pajares & Graham, 1999; Stajkovic et al., 2018).

Several studies have shown that students' mathematical performance at various educational levels in different educational systems is influenced by their mathematics self-efficacy. For example, Stankov et al. (2014) found a positive correlation between secondary students' mathematics self-efficacy and mathematics achievement. In another research with secondary students, Ayotola and Adedeji (2009) revealed a strong positive relationship between students' self-efficacy and mathematics achievement. The pupils who have a higher level of self-efficacy in mathematics are generally associated with higher levels of mathematical performance (Caprara et al., 2008). Although there is a well-established positive correlation between mathematics self-efficacy and mathematics achievement, this link may not hold true when examining different groups, such as districts or countries. For instance, a comparison analysis using the 2003 dataset from the Programme for International Student Assessment (PISA) conducted by Lee (2009) revealed that several high-achieving Asian nations (Japan, South Korea) obtained the lowest scores in terms of their belief in their ability to succeed in mathematics when compared to 41 other countries. Various cultures influence the development of human nature, resulting in a variety of forms (Bandura, 2002). The self-efficacy judgment of students is significantly influenced by their cultural environment (Chen & Zimmerman, 2007). On the other hand, Usher (2009) has explicitly investigated the factors that contribute to middle school students' belief in their ability to succeed in mathematics.

1.2. Students Like Learning Mathematics (SLM)

Liking learning mathematics, a critical affective factor linked to mathematical achievement, involves the emotional and behavioral responses of students towards their interest in mathematics (Mullis et al., 2012). Studies conducted internationally (Mohammadpour, 2012) have found that students who like learning mathematics tend to achieve better levels of mathematics achievement. In a study conducted using TIMSS 2011 data (Yoo, 2018), the effect of liking learning mathematics on Singapore pupils' mathematics achievement was analyzed. It was found that the attitude of eighth-grade boys towards "liking learning mathematics" does not have a significant effect on their mathematical achievement. Moreover, it has a slightly negative significant effect on girls' achievement in mathematics. This finding suggests that despite their high levels of achievement, eighth-grade pupils in Singapore may not like learning mathematics. In another study (Yavuz et al., 2017), TIMSS 2007 and TIMSS 2011 datasets were

used. According to the study's findings, students who participated in the TIMSS 2007 and liked learning mathematics had a higher level of mathematics achievement. On the contrary, "like learning mathematics" was observed to negatively affect the mathematics achievement of students participating in the TIMSS 2011. However, considering the size of the effect of this result, it was understood that the negative impact was negligible.

1.3. Students' Value Mathematics (SVM) as mediator and Parents' Valuing of Mathematics (PVoM) as moderator

Students' valuing of mathematics is connected to their external motivating factors and reflects their view on the significance and advantages of mathematics (Wigfield & Eccles, 2000). A study conducted on TIMSS 2011 data analyzed the impact of valuing mathematics on the academic achievements of fourth and eighth-grade students in South Korea, Singapore, and Finland using hierarchical linear modeling analysis. The findings revealed that students' valuing of mathematics had positive effects on mathematics achievement for students in South Korea and Singapore (Kim et al., 2013). Similarly, a study conducted by Phan et al. (2010) utilized TIMSS 2003 data and employed Hierarchical Linear Modeling (HLM) to examine the relationship between eighth-grade students' valuing of mathematics and their mathematics achievements in developed countries (Canada and the USA) and developing countries (Egypt and South Africa). The study revealed a positive correlation between students' valuation of mathematics and their achievement in mathematics. However, the study conducted by Arıkan et al. (2016) found no significant correlation between mathematics achievements and the eighth-grade students' valuing of mathematics who participated in the exams in Türkiye and Australia in 2007 and 2011. A notable aspect of the studies that were conducted is the emergence of varying outcomes across different countries. Additionally, in another study (Yavuz et al., 2017), according to both TIMSS 2007 and TIMSS 2011 data, no significant relationship was found between students' valuing of mathematics and mathematics achievement.

Parents and other family members serve as children's initial educators, impacting their acquisition of mathematical knowledge and skills (Phillipson et al., 2017). Consequently, parents' attitudes toward math education can be seen as valuable assets shaping children's early mathematical development (Hawighorst, 2005). Students who felt their parents valued mathematics showed higher motivation levels compared to others (Lazarides et al., 2016). On the other hand, another study showed that early numeracy activities could be attributed to parental mathematics values, but they did not relate to children's mathematics achievement (Missall et al., 2015). An individual's increasing self-efficacy in math might persuade their family members to value math more, which fosters positive emotions about mathematics throughout the family.

1.4. Present study

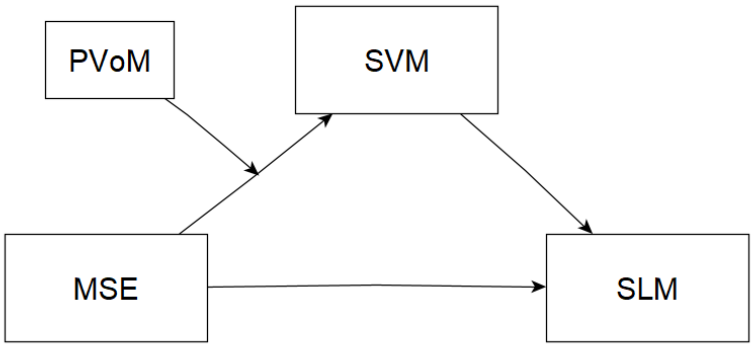
The purpose of this study is to examine the impact of Mathematics Self-Efficacy on Students Like Learning Mathematics, utilizing data from TIMSS 2019, with a focus on Students Value Mathematics as the mediator and Parents' Valuing of Mathematics as the moderator. Based on Bandura's (1997) general theory, expectations of self-efficacy influence critical outcomes such as people's activity selection, effort spent, and persistence when confronted with challenges. Students who had stronger self-efficacy in mathematics were more likely to like the course (Laranang & Bondoc, 2020). Pinxten et al. (2014) expanded on this by finding a reciprocal relationship between enjoyment and competence views in mathematics, with both characteristics influencing achievement and perceived effort expenditure. These findings show that people who are more confident in their mathematics ability will like the topic more. Therefore, the first hypothesis is that there is a relationship between mathematics self-efficacy and students like learning mathematics (H_1).

Jacquelynne Eccles and her colleagues designed the expectancy-value theory. According to the theory, achievement-related choices are driven by a combination of individual achievement expectations and personal assessment of tasks in specific domains. Children, for example, are more inclined to participate in an activity if they believe they will succeed and value the activity (Wigfield & Eccles, 2000). In this line, researchers suggest that it is necessary to effectively demonstrate the logical and valuable aspects of mathematics (Wilkerson, 2020). Güner (2012) further proposes that recognizing the utility of mathematics can contribute to the development of a positive attitude towards the subject. Perceiving mathematics as valuable and relevant to daily life often fosters a positive engagement with the subject among individuals. Therefore, the second hypothesis is that students' valuing of mathematics plays a mediating role between mathematics self-efficacy and students like learning mathematics (H_2).

Enhanced confidence in mathematical proficiency motivates individuals to participate in math-related activities actively, actively seek avenues for expanding their mathematical knowledge, and openly express their enthusiasm for mathematics to their parents. Moreover, when parents place importance on mathematics and offer encouragement and assistance for mathematical education, their children tend to develop positive attitudes towards mathematics. Therefore, the third hypothesis states that parents' valuing of mathematics (PVoM) has a moderate mediating effect on students' value of mathematics (SVM) on the link of mathematics self-efficacy (MSE) with students like learning mathematics (SLM) (H_3). Figure 1 shows the moderated mediation model hypothesized as H_1, H_2 and H_3.

Figure 1

Moderated Mediation Model Examined in the Study



In the literature, although there are numerous studies showing that mathematics self-efficacy affects mathematics achievement (Ayotola & Adedeji, 2009; Stajkovic et al., 2018), the value placed on mathematics affects mathematics achievement (Kim et al., 2013; Phan et al., 2010;) and that liking learning mathematics influences mathematics achievement (Mohammadpour, 2012), there are also studies indicating that these variables (MSE, SLM and SVM) have no effect or have a negative effect (Arıkan et al., 2016; Lee, 2009; Yavuz et al., 2017; Yoo, 2018). This situation may stem from cultural differences. According to data on the attitudes of Turkish parents and teachers, children in Turkish society are socialized within a collectivist culture where individual needs, interests, autonomy, and self-sufficiency are frequently disregarded. This results in a prioritization of academic success in a child's socialization and education (Aslan & Cansever, 2009). Also, there is no other research in the literature that examines all of the variables of mathematics self-efficacy, like learning mathematics, students value mathematics and parents' valuing of mathematics together. In this study, the aim is to examine Türkiye, a country lagging behind in TIMSS.

Moreover, there is a significant gap in the existing literature: no previous research has examined mathematics self-efficacy, students' liking of mathematics, students' valuing of mathematics, and

parents' valuing of mathematics together within a single model. This study aims to address this gap by examining these interrelated variables simultaneously in Türkiye, a country that has consistently lagged behind in the TIMSS assessments. By understanding how students' and parents' attitudes toward mathematics interact to influence students' enjoyment of mathematics, the study seeks to provide insights for educators, policymakers, and curriculum developers aiming to enhance students' positive attitudes toward mathematics in collectivist cultural contexts. Therefore, this research is important not only for contributing to the international literature on mathematics education but also for guiding educational reforms and family involvement initiatives in Türkiye and similar societies.

2. Methodology

2.1. Sample

In this study, the student dataset from TIMSS 2019 was used. TIMSS is an international survey and assessment method that primarily focuses on fourth and eighth-grade students' mathematics and science achievement. Besides reporting student achievement, TIMSS collects several variables about teachers, curriculum, home and school contexts, as well as psychological variables about the courses. A total of 72 countries participated in TIMSS 2019 from different regions and cultures. We focused on 4,077 eighth-grade students from Türkiye sample. According to Little's MCAR test, the mechanism of missing data was not MCAR (χ^2= 2069.89, df = 1666, p< 0.001). Thus, 477 (%11) students with missing data were considered as missing at random (MAR). The listwise deletion method was used to handle missing data; further analyses were carried out with 3600 students. 50.5% of the sample was female. The mean age of the students was 13.9 years (±0.41). Through the international benchmark estimations of students' mathematics achievement, 19.7% were below 400, 24.3% were at or above 400 but below 475, 24.6% were at or above 475 but below 550, 19.9% were at or above 550 but below 625, and 11.6% were at or above 625 in terms of PV1MAT. Their parents' highest education level frequencies are as follows: 12.8% university or higher, 7% post-secondary but not university, 27.3% upper secondary, 28.9% lower secondary, 16.9% some primary, lower secondary or no school, and 3.9% information.

2.2. Measures

We used TIMSS's measures named Students Like Learning Mathematics (SLM), Mathematics Self-Efficacy (MSE), Students' Value Mathematics (SVM), and Parents' Value Mathematics (coded as BSBM20H) as moderator variable.

2.2.1. Students like learning mathematics

SLM was constructed by combining items coded as follows:

Table 1

SLM Items

Code	Items
BSBM16A	Enjoy learning mathematics
BSBM16B	Wish have not to study math†
BSBM16C	Math is boring†
BSBM16D	Learn interesting things
BSBM16E	Like mathematics
BSBM16F	Like numbers
BSBM16G	Like math problems
BSBM16H	Look forward to math class
BSBM16I	Favorite subject

Note: †Reverse items, Items were 4-point Likert type as 1: Agree a lot, 2: Agree a little, 3: Disagree a little, 4: Disagree a lot.

First, we checked the assumptions. Multivariate outliers were checked by Mahalanobis Distance (p<0.001) and 105 outliers were removed from the datasets. Exploratory factor analysis (EFA) was performed with the remaining 3,495 individuals. Through the multicollinearity assumption, VIF values ranged between 1.52 to 4.64, tolerance values ranged between 0.22 to 0.66, and CI values ranged between 1.00 to 16.22. This means that there is no multicollinearity (Tabachnick et al., 2020). We examined the multivariate normality via Mardia's Multivariate Skewness coefficient, and it was statistically significant (skewness = 4878.26, p<0.01). The multivariate normality assumption was violated through the analysis. We chose the unweighted least squares (ULS) factor extraction method for EFA because of its robustness against violation of the multivariate normality assumption.

We used parallel analysis (PA), minimum average partial (MAP), and Hull methods for factor retention. PA, MAP, and Hull suggested a unidimensional structure. We examined the factor structure of the SLM using a polychoric correlation matrix and the ULS factor extraction method. Results suggest that a unidimensional structure was sufficient. The total explained variance was 70.85% and factor loadings ranged between 0.68 to 0.95. According to explained variance and factor loadings, the unidimensional structure was appropriate for SLM. We used the total score of SLM for mediation analysis. Reliability analysis points out that McDonald's Omega was 0.95 and Cronbach's Alpha was 0.93 for SLM, indicating high internal consistency.

2.2.2. Mathematics self-efficacy

MSE was constructed by combining items coded as follows:

Table 2

MSE Items

Code	Items
BSBM19A	Usually do well in math.
BSBM19B	Mathematics is more difficult†
BSBM19C	Mathematics is not my strength†
BSBM19D	Learn quickly in mathematics.
BSBM19E	Math makes nervous†
BSBM19F	Good at working out problems
BSBM19G	I am good at mathematics.
BSBM19H	Mathematics harder for me†
BSBM19I	Math makes confused†

Note: †Reverse items, Items were 4-point Likert type as 1: Agree a lot, 2: Agree a little, 3: Disagree a little, 4: Disagree a lot.

Through the assumptions, 75 multivariate outliers were detected and removed. EFA was performed with the remaining 3,525 individuals. VIF values ranged between 1.69 to 2.79, tolerance values ranged between 0.36-0.59, and CI values ranged between 1.00 to 15.09. This means that there is no multicollinearity (Tabachnick et al., 2020). We examined the multivariate normality via Mardia's Multivariate Skewness coefficient, and it was statistically significant (skewness = 1471.33, p<0.01). We chose ULS factor extraction method for EFA because of its robustness against violation of the multivariate normality assumption.

We used PA, MAP, and Hull methods for factor retention. PA suggested a unidimensional structure, whereas MAP and Hull suggested two factors. The unidimensional structure explained a total variance of 61.09%. Factor loadings for the unidimensional structure ranged between 0.63 and 0.84. According to the variance and factor loadings explained, the unidimensional model was appropriate for MSE. Therefore, we used the MSE total score for mediation analysis. McDonald's Omega was 0.93, and Cronbach's alpha was 0.90 for MSE, indicating high internal consistency.

2.2.3. Students value mathematics

Students Value Mathematics (SVM) was constructed by combining items coded as follows:

Table 3

SVM Items

Code	Items
BSBM20A	Mathematics will help me.
BSBM20B	Need maths to learn other things.
BSBM20C	Need math to get into <uni>
BSBM20F	Get ahead in the world.
BSBM20I	Important to do well in math

Note: Items were 4-point Likert type as 1: Agree a lot, 2: Agree a little, 3: Disagree a little, 4: Disagree a lot.

Through the assumptions, 119 multivariate outliers were detected and removed. EFA was performed with the remaining 3,481 individuals. VIF values ranged between 1.51 to 2.16, tolerance values ranged between 0.46 to 0.66, and CI values ranged between 1.00 to 8.55. This means that there is no multicollinearity (Tabachnick et al., 2020). We examined the multivariate normality via Mardia's Multivariate Skewness coefficient, and it was statistically significant (skewness = 6769.86, p<0.01). We chose ULS factor extraction method for EFA because of its robustness against violation of the multivariate normality assumption.

PA, MAP, and Hull suggested a unidimensional structure. Thus, we examined the unidimensional factor structure of SVM using a polychoric correlation matrix and ULS factor extraction method. The total explained variance was 65.99%, and factor loadings ranged between 0.68 and 0.89. So, SVM was unidimensional. We used the SVM total score for mediation analysis. McDonald's Omega was 0.88, and Cronbach's Alpha was 0.81 for SVM, indicating high reliability.

2.3. Moderator variable

The moderator variable was coded BSBM20H (Parents think math is important) named as PVoM in the current study. It was also a 4-point Likert scale like the other variables (1: Agree a lot, 2: Agree a little, 3: Disagree a little, 4: Disagree a lot). The distribution of the moderator variable was analyzed by frequencies for each category. Frequencies by categories were 72.30% (n= 2,601) for 1, 19.40% (n=699) for 2, 4.80% (n=173) for 3, and 3.5% (n=127) for 4. To examine the moderator effect for every category, we combined the 2, 3, and 4 categories. Kılıç and Uysal (2021) stated that combining categories of variables may be acceptable in terms of analyses. Thus, we combined the categories like 1 (Agree a lot), which was the most chosen category, and 2 (the others), which includes 2nd, 3rd, and 4th categories.

2.4. Data analysis

James and Brett (1984) proposed the idea of moderated mediation, which determines if W affects the size of an indirect effect (Clement & Bradley-Garcia, 2022; Preacher et al., 2007). Moderated mediation examines whether the mediational pathways differ across moderator levels. Therefore, we used moderated mediation analysis to examine the relationship between MSE, SLM, SVM, and the moderator variable, which was about Parents' thinking that math is important (BSBM20H) named as PVoM.

First, we investigated the dataset in terms of moderated mediation assumptions. These assumptions include the following: the observations are independent, there is a linear relationship between the variables, the error values have equal variances (homoscedasticity), there is no multicollinearity among the independent variables, and the error values are normally distributed (Clement & Bradley-Garcia, 2022; Hayes, 2022). We used the Durbin-Watson statistic to examine the independence of residual terms. The Durbin-Watson statistic in our dataset is 1.89, indicating that the assumption of independence of residuals is satisfied (Field, 2024). We examined the scatter plot created via

unstandardized predicted values and standardized residuals. Because the data is horizontal, the homoscedasticity assumption was held. For multicollinearity, we examined the VIF, CI, and TV values. VIF, TV, and CI values ranged between 1.18-1.50, 0.59-0.85, and 1.00-6.45, respectively. These results indicate that the multicollinearity assumption was held (Tabachnick et al., 2020). We used the observed cumulative probability and expected cumulative probability graph to examine the normality of error terms. Because the graph is linear like the y=x line, this assumption was held.

Process Macro is mainly used for mediation, moderation, or related analysis. We assessed the importance of indirect effects by employing the bootstrapping approach with 5,000 resamples to obtain 95% confidence intervals (Hayes, 2022). We conducted EFA analysis with Factor software (Lorenzo-Seva & Ferrando, 2023) and moderated mediation analysis with SPSS version 26 with Process Macro (v4.2) (Hayes, 2022) using Model 7.

3. Results

3.1. Descriptive statistics

We examined the mean (sd), skewness, kurtosis, and bivariate correlations among variables. The means of the variables were 18.84 (±7.47), 21.78 (±7.00), and 8.39 (±3.41) for SLM, MSE, and SVM, respectively. Skewness of the SLM, MSE, and SVM were (0.53), (-0.06), and (1.27). Kurtosis of the SLM, MSE, and SVM were (-0.66), (-0.72), and (1.405). The moderator variable's (Parents think math is important) categories' percentages were 1 for 72.30% (n = 2,601) and 2 for 27.70% (n = 999). Bivariate correlations in terms of PVoM (Parents Value on Mathematics) categories are presented in Table 4.

Table 4

Bivariate Correlations

Variable	SLM	MSE	SVM
SLM	-	0.65**	0.55**
MSE	0.71**	-	0.30**
SVM	0.56**	0.37**	-

Note: **p<0.01, MSE: Mathematics Self-Efficacy, SVM: Students Value Mathematics, SLM: Students Like Learning

The correlation matrix in Table 4 shows the correlation analysis results obtained from different groups in the lower triangle and upper triangle. The lower triangle of the correlation matrix in Table 4 shows the correlations obtained only from the group that marked "Agree a lot" on the item Parents Value on Mathematics (PVoM), while the upper triangle of the matrix shows the correlations obtained from the group excluding those who marked "Agree a lot". Accordingly, when the correlations obtained from the "agree a lot" group are analyzed, the correlation between MSE and SVM is 0.37, the correlation between SVM and SLM is 0.56 and the correlation between MSE and SLM is 0.71. These correlations were 0.30, 0.55 and 0.65, respectively, in the group marking other than agree a lot to PVoM. It can be said that the correlations are higher in the group that marked Agree a lot. Finally, the correlation coefficients obtained from the whole group without grouping by PVoM are 0.38, 0.58 and 0.70, respectively. It was observed that all correlations were significant at the 0.01 level. Correlations between each variable for subgroups and all groups were statistically significant and relatively moderate-high. Accordingly, hypothesis H_1 was accepted.

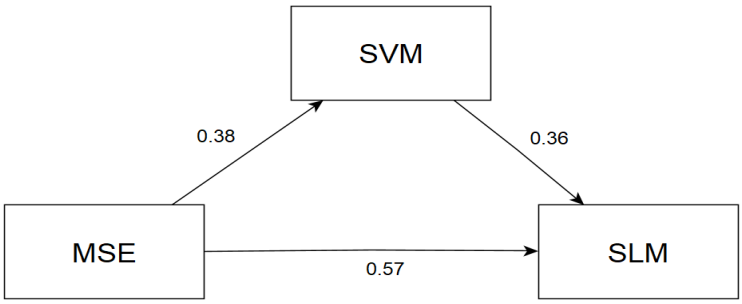
3.2. Mediation and moderated mediation analysis

First, mediation analysis showed that MSE had a significant predictive effect on SVM (β= 0.18, p<0.01). Similarly, MSE (β = 0.61, p<0.01) and SVM (β = 0.79, p<0.01) had a significant predictive effect on SLM. The total effect was 0.75 (t= 59.44, p<0.01, LLCI: 0.73 - ULCI: 0.78) and the indirect effect of SVM on SLM was 0.15 (LLCI: 0.13-ULCI:0.16). Therefore, SVM partially mediated the effect of MSE on SLM. Accordingly, H_2 (students value mathematics plays a mediating role between mathematics self-efficacy

and students like learning mathematics) was accepted. Standardized estimates are presented in Figure 2.

Figure 2

Standardized Estimates of the Mediation Model



The indirect effect accounted for 19.41% of the total effect. After conducting an analysis of the mediating impact, we further investigated the moderated mediation effect to see if parents' perception of the importance of math influenced the mediating effect of SVM in the relationship between MSE and SLM. The analysis revealed that MSE and PVoM highly influenced SVM, explaining 26% of the variability in SVM (see Table 5). The impact of parents' thoughts considerably influenced the relationship between MSE and their value for mathematics (interaction effect $\beta = 0.05$, $p<0.05$; $\Delta R^2 = 0.001$). The results of the analysis showed that there was a significant difference in the indirect effect of MSE on SLM between the category of moderator variable that was high (categorized as 1 for agree a lot) and the other categories (categorized as 2 for the rest) as seen in Figure 3.

Figure 3

The Moderation Effects of Both Groups of Moderator Variables (PVoM)

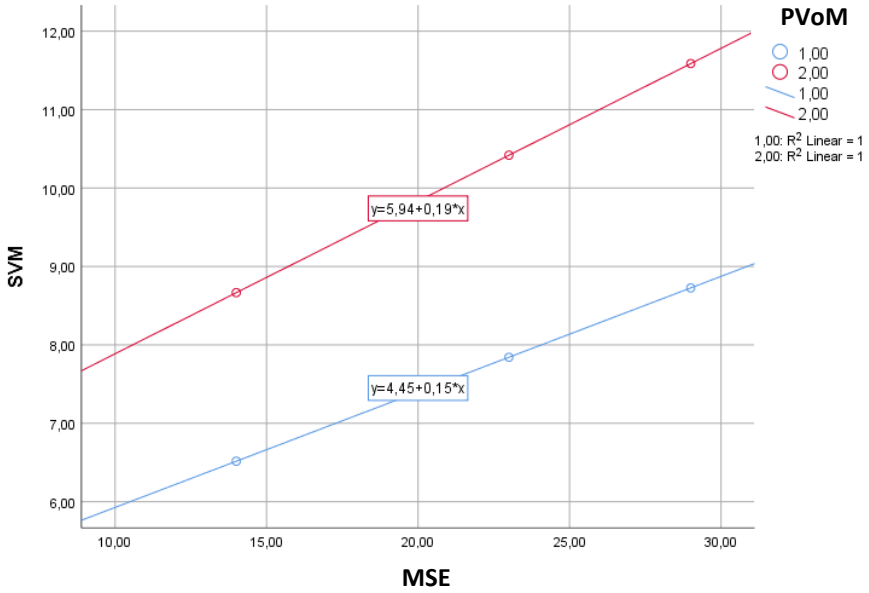


Table 5

Unstandardized Coefficients for the Moderated Mediation Model

	M (SVM [Students Value Mathematics])			Y (SLM [Students Like Learning Mathematics])		
	Coeff.	SE	t	Coeff.	SE	t
X (MSE)	0.10	0.02	4.44**	0.61	0.01	50.24**
M (SVM)	-	-	-	0.79	0.03	31.97**
W (Parents)	1.49	0.43	3.47**	-	-	-
X.W	0.05	0.02	2.65**	-	-	-
Constant	2.97	0.53	5.65**	-0.97	0.27	-3.52**
	R^2 = 0.26, F =413.50, p<0.01			R^2 = 0.61, F =2778.30, p<0.01		
Conditional Indirect effects of MSE on SLM						
Parents think math important	Effect			BootSE	BootLLCI	BootULCI
1 (Agree a lot)	0.12			0.01	0.10	0.13
2 (The others)	0.15			0.02	0.12	0.19
Index of moderated mediation (difference between conditional indirect effects)						
Parents think math important	Index			BootSE	BootLLCI	BootULCI
	0.04			0.02	0.00	0.07

Note: **p<0.01, Level of all confidence intervals are 95%, number of bootstrap samples for percentile bootstrap confidence intervals: 5000

Further results revealed that PVoM moderated the mediating effect. Therefore, the indirect effect for students whose parents think math is important "Agree a lot" group is lower than the others (group 2). These findings indicate that the indirect effects of MSE on SLM with the mediator role of SVM are moderated by parents thinking about mathematics, whether it is important or not. Accordingly, H_3 (parents' valuing of mathematics (PVoM) has a moderate mediating effect on students value of mathematics (SVM) on the link of Mathematics Self-Efficacy (MSE) with Students Like Learning Mathematics (SLM) was accepted. This finding reveals the effects of whether parents think math is important on students value of mathematics. Note that it is important that perceptions of parents were reported by students. Therefore, these findings are crucial as they indicate the reflections of parents' perceptions about mathematics on students.

4. Discussion

This study investigates the influence of self-efficacy, valuing mathematics, and parental attitudes on students' mathematical achievement using data from TIMSS 2019. According to our findings, the first hypothesis that there is a relationship between mathematics self-efficacy and liking learning mathematics was confirmed (H_1). These findings are consistent with the results of previous research (Laranang & Bondoc, 2020). As students feel competent in mathematics, their achievement may increase (Ayotola & Adedeji, 2009; Bandura, 1997), and they may enjoy learning mathematics more with this feeling of satisfaction. On the contrary, Ertürk and Erdinç Akan (2018) found that fourth and eighth-grade students' self-confidence in mathematics negatively predicted mathematics achievement. Similarly, in Çavdar's (2015) study based on TIMSS 2011 Türkiye data, the variable of self-confidence in mathematics had a negative effect on mathematics achievement. This difference may be attributed to the fact that the samples used in previous studies and our study differ, and we utilized TIMSS data from different years. Moreover, the mathematics curriculum in Türkiye has undergone two revisions since the aforementioned studies, and changes in curricular content and instructional methods may have influenced the observed outcomes.

The second hypothesis that students value mathematics plays a mediating role between mathematics self-efficacy and liking learning mathematics was confirmed (H_2). These findings are consistent with the results of previous research. For example, Andersen and Smith (2024) analyzed TIMSS 2015 data from three countries (Norway, Italy, and Canada) and found that students' valuing of mathematics subjects is very important for self-concept. In another study, Hwang et al. (2017) examined the data of US and Finnish students in TIMSS 2011. In this study, a significant positive relationship was found between SLM and SVM in both countries. There is also a study (Yavuz et al., 2017) examining the effect of these variables on mathematics achievement with TIMSS 2007 and 2011 Türkiye data. As a result, students enjoy learning mathematics more when they value mathematics. In addition, if they also value mathematics, they like mathematics more (Hwang et al. 2017). Therefore, if a student with low mathematics self-confidence values mathematics, the likelihood of liking mathematics will increase.

The third hypothesis that parents' valuing of mathematics (PVoM) has a moderate mediating effect on students' value of mathematics (SVM) on the link of Mathematics Self Efficacy (MSE) with Students Like Learning Mathematics (SLM) was confirmed (H_3). These findings are consistent with the results of previous research. Similarly, Yoo (2018) found positive relationships between parental involvement in education and SLM in a study analyzing the TIMSS 2011 data of 8th-grade students. In addition, in the same study, significant positive relationships were found between confidence in Mathematics and parental involvement in education and between confidence in Mathematics and SLM. When parents place a high value on mathematics, this affects how much their children value mathematics. This influence arises from the parents' role in shaping the home learning environment (Trickett et al., 2022). Additionally, parents are responsible for organizing their children's leisure time after school. By valuing mathematics, parents provide guidance that encourages their children to also value and develop an interest in mathematics.

On the other hand, the indirect effect of SVM was higher in the "not agree a lot" group than in the "agree a lot" group. This difference might stem from perceived parental pressure among students, potentially leading to anxiety rather than a genuine, loving mathematical learning (Macmull & Ashkenazi, 2019). It's worth noting that these perceptions were reported by the students themselves. Moreover, intrinsic motivators seem to have a greater impact on learning mathematics compared to extrinsic motivators. Research suggests that children are more likely to engage in activities when they believe in their ability to succeed and find value in the activity (Wigfield & Eccles, 2000). This underscores the importance of effectively demonstrating the logical and valuable aspects of mathematics (Wilkerson, 2020). These findings align with expectancy-value theory, a well-established framework in educational research for studying motivation (Rodríguez et al., 2021).

The findings of the study show that mathematics self-efficacy positively affects students ' learning of mathematics. Therefore, it seems important to improve students' mathematics self-efficacy. In this regard, it may be necessary to revise Türkiye's education and training policies and to take steps to improve students' mathematics self-efficacy. By supporting students with low to moderate mathematics self-efficacy in developing a sense of competence in mathematics, their liking for learning mathematics can be enhanced. On the other hand, measures should be taken to ensure that the self-efficacy of students with high mathematics self-efficacy doesn't decrease. According to the other findings of this study, it seems important for both parents and students to value mathematics to foster a liking for learning mathematics. Therefore, raising awareness about the importance of mathematics is crucial. To achieve this goal, the Ministry of National Education can develop policies. Additionally, family education programs can be designed to support children with their parents. When teaching mathematics, teachers can make intriguing introductions by emphasizing the importance of the subject.

This research has some limitations. First of all, since it is a cross-sectional study, it does not provide information on causality. Therefore, longitudinal or experimental studies can be designed in the future.

Secondly, the data are limited to the measurement tools created by TIMSS. A similar study can be applied with other scales on the same variables. The third limitation is that the study was conducted using only Turkish data. This study can be conducted with data from all countries in TIMSS 2019. In addition, according to the results of TIMSS 2019, the most successful countries can be compared with the data of Türkiye, which ranks in last place.

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